NASA TECHNICAL NOTE

NASA TN D-3655

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SONIC-BOOM MEASUREMENTS DURING BOMBER TRAINING OPERATIONS IN THE CHICAGO AREA

by David A. Hilton, Vera Huckel, and Domenic J. Maglieri

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • OCTOBER 1966

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SUMMARY

Measurements have been made with the aid of bomber airplanes in an attempt to evaluate the effects of the atmosphere on the sonic-boom pressure signatures. Data are presented for various atmospheric situations ranging from quiescent to turbulent and for a wide range of surface temperatures. Statistical analyses have been performed for both the overpressure and impulse data, and these data are compared with similar data from fighter-type airplanes.

The measured sonic-boom signatures were noted to vary widely in both peak amplitude and wave shape because of atmospheric dynamic effects. The distortions were associated with the rapidly rising portions (bow and tail wave) of the boom signatures. The highest overpressures were associated with peaked signatures and the lowest overpressures, with rounded-type signatures. The variations of the overpressures and impulses may be represented over a significant range by log normal distributions, the overpressures having a markedly wider range of variations than the impulses. From the data evaluated to date, similar variations in pressure signatures are noted for the shorter wave lengths produced by fighter airplanes and for the longer wave lengths produced by bomber airplanes.

INTRODUCTION

Measurements of sonic-boom signatures produced by fighter-type airplanes in steady-level flight have indicated significant variations in signature shape. These wave-shape variations have been attributed largely to the effects of the atmosphere, particularly in the lower layers near the surface of the earth. (See refs. 1, 2, and 3.) Evaluation of the effects of the atmosphere on sonic-boom signatures of long durations is of considerable interest for extrapolation to the operating conditions of the proposed supersonic transport. In this regard, the opportunity was taken to collaborate with U.S. Air Force personnel during bomber-airplane training exercises in the Chicago, Illinois, area in order to obtain such data for relatively large supersonic airplanes for a range of weather conditions. The data obtained during these studies (some of which are reported briefly in ref. 3) are compared with similar sonic-boom data for bomber airplanes under somewhat different weather conditions (previously published in refs. 1, 2, and 4). A summary of sonic-boom complaints and claims arising from flights in the Chicago area is presented in the appendix.

SYMBOLS

I_o — impulse of positive phase of sonic-boom ground-pressure signature, pound-second/foot^2 (newton-second/meter^2)

M — Mach number

Δp_o — pressure rise across shock wave at ground level, pounds/foot^2 (newtons/meter^2)

Δt_o — time duration of positive phase of sonic-boom ground-pressure signature, seconds

Subscripts:

calc — calculated

meas — measured

The following symbols and definitions are used in table I:

Surface winds:

First number in column is direction (true north) from which wind is blowing; second number in column is wind velocity in knots.

Cloud cover:

○ — clear

⦶ — scattered

⦶⦶ — broken

⊕ — overcast

Precipitation:

R rain

S snow

A minus sign before type of precipitation indicates that the precipitation was light; otherwise, precipitation was moderate.

APPARATUS AND METHODS

Most of the information recorded in the present report relates to test flights accomplished in the Chicago, Illinois, area. Also included for comparisons are data from previous sonic-boom flight tests from the Edwards Air Force Base area (ref. 2), the Oklahoma City area (ref. 1), and the St. Louis area (ref. 4). Unless otherwise noted, the following discussions of procedures and results relate to the Chicago studies.

Test Conditions

The flights for which data were obtained in the present studies were made within the flight corridor indicated in figure 1. This general area of Chicago has an elevation of about 600 feet (182.9 m) above sea level and has an urban population of about 3 500 000. About 22 flights were made in the period February to March, 1965.

Locations of the five measuring stations are shown on the map of figure 1. Stations 3 and 5 were located on or near the proposed ground track, and the other three stations were located at a distance of 4 to 8 miles on either side. Four of the five stations were located at ground level, and station 5 was located on the top of a 40-story building. Three of the stations were located in the lakeshore area so that the shock wave propagated

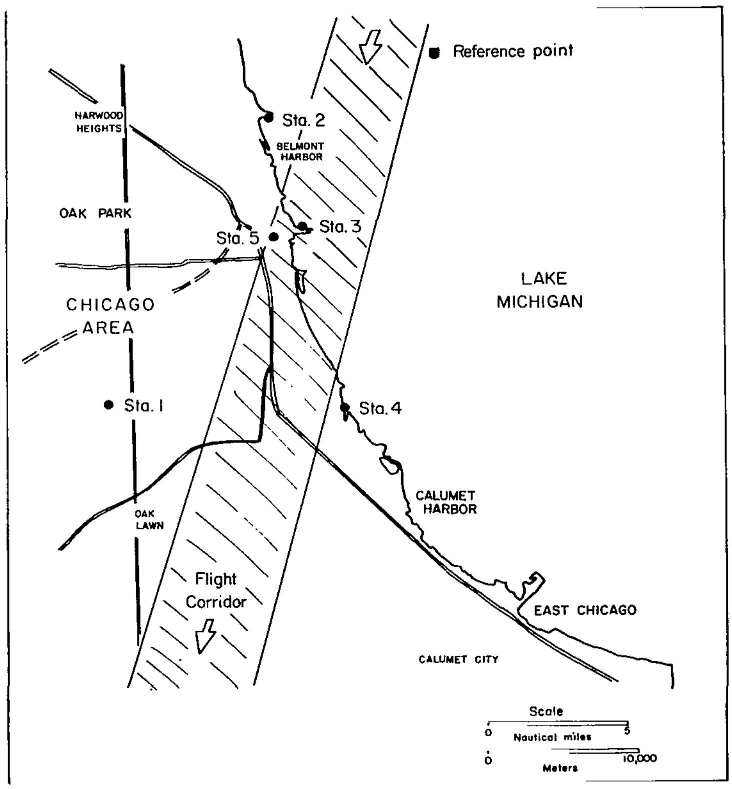


Figure 1.- Planview of Chicago area showing flight corridor, flight reference point, and sonic-boom measuring stations.

from over the lake in the direction of the stations without encountering any populated areas or large structures. Although no large structures were located in the immediate vicinity of station 1 at Midway Airport, it should be noted that the shock waves from the airplane propagated through that portion of the atmosphere existing above a large built-up area. (See ref. 4.)

Test Airplanes

A photograph of an airplane of the type used in these tests is shown in figure 2. The airplane has an overall length of 96.8 feet (29.50 m) and a gross mass varying from 88 200 to 105 000 pounds (40 007 to 47 627 kg). Details of the airplanes such as area distribution and shape factors are given in reference 5. The airplanes were maintained and operated by U.S. Air Force personnel.

L-61-1031

Figure 2.- Photograph of airplane of type used during tests.

Airplane Operations and Positioning

The airplanes were operated in the altitude range of 38 000 to 48 000 feet (11 582 to 14 630 m) and in the Mach number range from 1.2 to 1.66. The flights were made generally in a north-south direction within the corridor shown in figure 1. The airplane was positioned in this flight corridor by means of onboard navigation equipment, and the flight track was established by ground radar equipment operated by the U.S. Army. The airplanes were generally in steady level flight at least 30 nautical miles (55 560 m) prior to passing the reference point in the flight corridor shown in figure 1. After passing this reference point, altitude and heading were maintained with only small variation over the test area. During this latter phase of the flight, the Mach number of the airplane was allowed to decrease slightly but this decrease occurred at such a rate that there were no significant effects on the measured data. Data relative to the operating conditions of the airplane (such as altitude, Mach number, aircraft weight, and lateral displacement from the reference point) obtained from the onboard equipment and ground radar tracks were supplied by the U.S. Air Force and are included in table I. These data relate to the airplane operating conditions at the time the airplane was over the reference point.

Atmospheric Observations

Climatological data obtained in the vicinity of Midway Airport are presented in table I for the time periods of the test flights. These data include such characteristics as surface temperature, surface winds, and precipitation. Surface temperatures ranged from about 3° to 44° F $(257^{\circ}$ to 279.8° K) and steady surface winds, from about 7 to 28 knots (3.6 to 14.4 m/sec). No rawinsonde soundings were available for this testing area; however, the U.S. Air Force supplied some synoptic data including temperature, wind velocity, and wind direction at various altitudes up to and above the flight altitudes. These latter data are presented in table II.

Pressure Instrumentation

Sonic-boom-pressure measurements were made near a large flat reflecting surface at all the stations. Each microphone was shock mounted 6 inches above the reflecting surface with its sensitive element parallel to the reflecting surface. Wind screens were employed to minimize the effects of wind on the microphone readings.

Each station consisted of from two to five microphones. The layouts for each of the stations with respect to the flight track are given in figure 3. Note that the individual microphones are separated by distances of 100 feet (30.48 m) at all stations (except station 5 which was located on the top of a 40-story building) in an attempt to observe variations due to atmospheric effects.

The main components of the ground measuring systems used for sonic-boom pressures are the same as those described in more detail in references 1, 2, and 6. Each channel of the system used in the experiments consisted of a modified microphone, tuning unit, dc amplified, and oscillograph recorder. The usable frequency range for all data presented herein was from

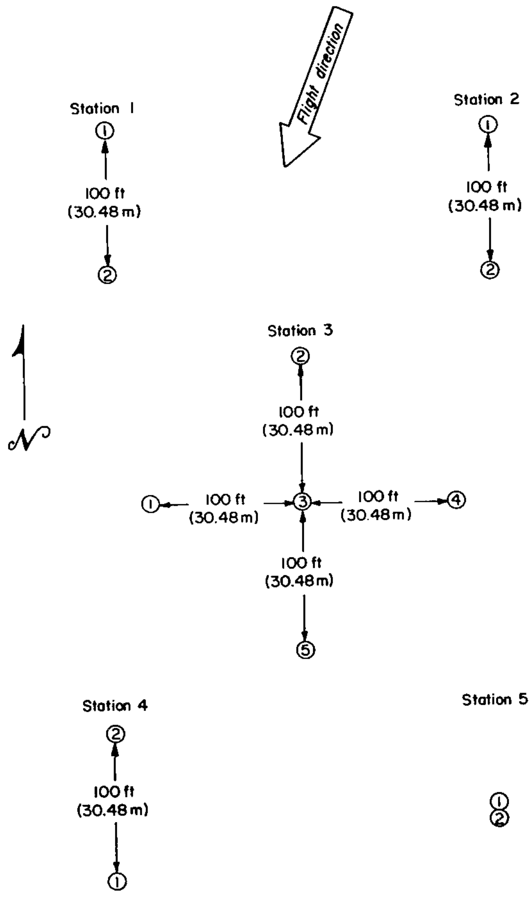


Figure 3.- Arrangement of microphones at each of the sonic-boom measuring stations. (Numbers in circles designate microphones.)

0.02 to 5 000 cps. The microphones have a dynamic range from about 70 to 150 dB and were field-calibrated statically before each test by means of a pressure bellows and a sensitive manometer. Prior to field installation, frequency-response curves were measured for all microphone systems.

Sonic-Boom Calculations

Sonic-boom calculations for the on-the-track nominal overpressure, positive period, and positive impulse values of this report were performed using the method outlined in the appendix of reference 7 (which considers both lift and volume contributions) and assuming the standard atmosphere of reference 8. The calculated nominal values which include data for the Chicago area, St. Louis area, Oklahoma City area, and Edwards area experiments are presented for reference in table III.

RESULTS AND DISCUSSIONS

Wave Shapes

Sonic-boom pressure signatures of the type obtained in the measurements of the present studies are illustrated in figure 4. Since signatures vary markedly in character it is useful to categorize them (as was done in ref. 1). The types of measured wave shapes are presented on the left-hand side of figure 4, and word descriptions, on the right-hand side. When wave shapes did not fall naturally into one of the categories illustrated, a two-letter designation was assigned; for instance, a type "NP" was judged to be between type "N" and type "P." Also shown in the figure are definitions of such quantities as positive impulse I_o and the duration of the positive phase of the wave Δt_o.

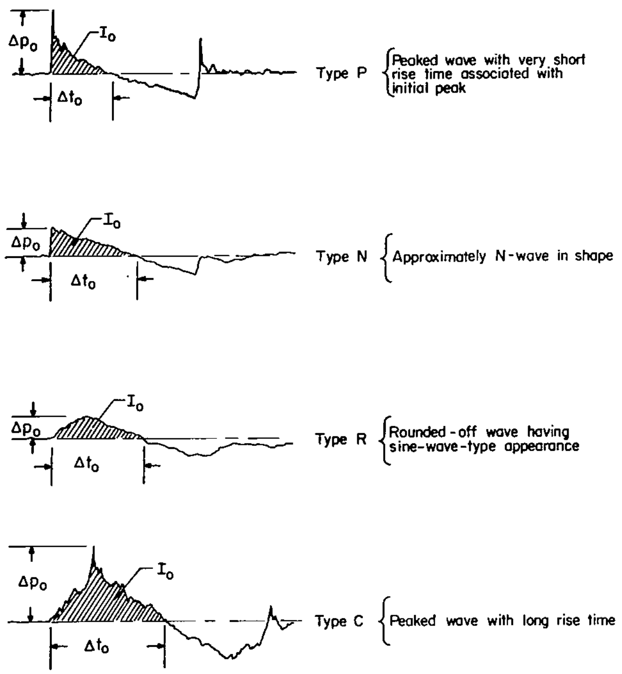
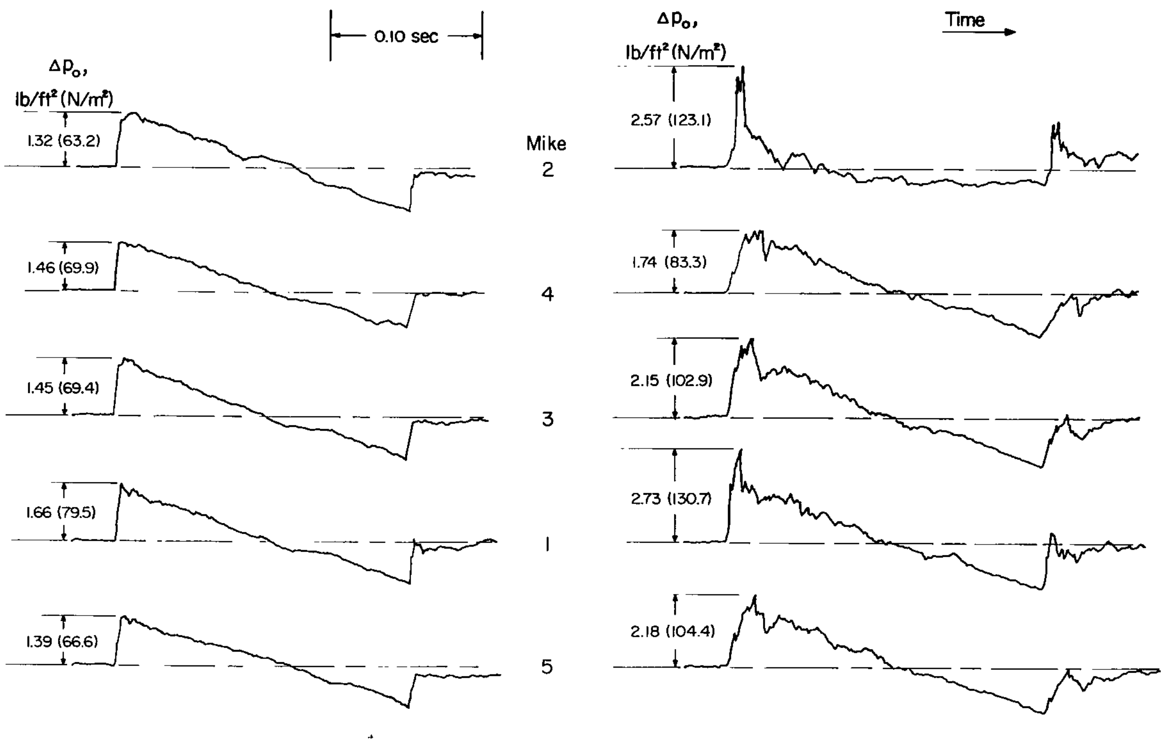


Figure 4.- Tracings of actual sonic-boom pressure-time histories showing some categories of waveforms measured near ground level during the Chicago tests.

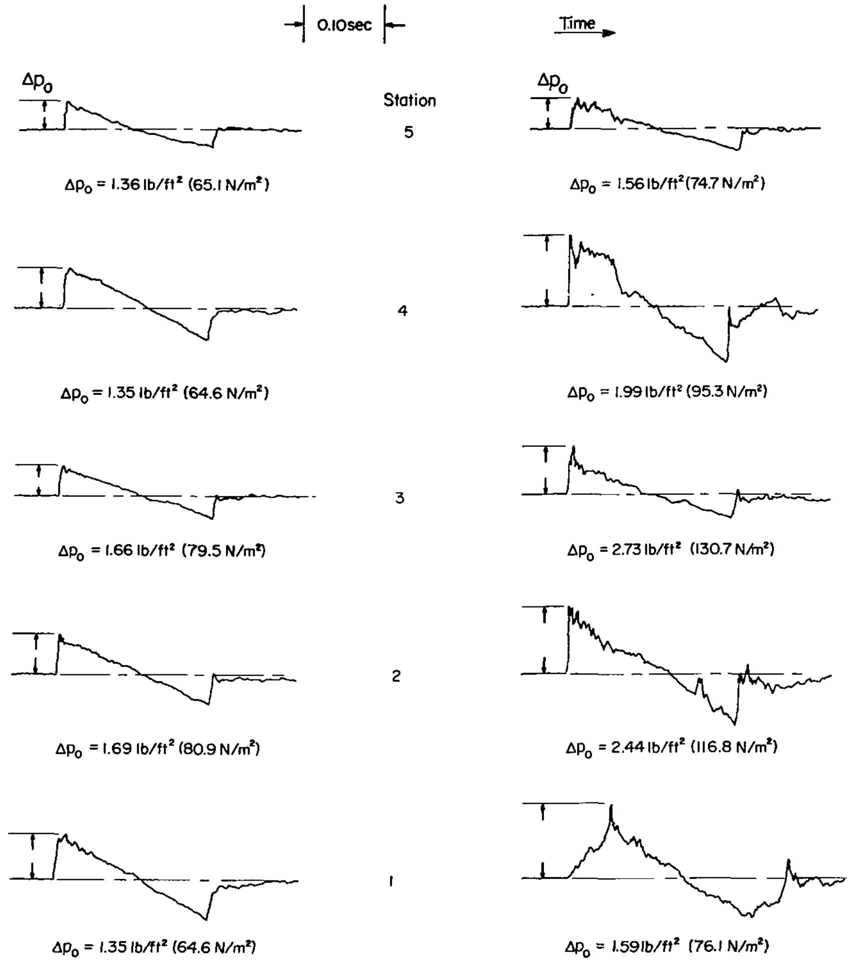
Further illustrations of the variations in sonic-boom-signature shape at a given measuring station are shown in figure 5. The data shown are tracings of actual measured signatures from the five microphones at station 3. (See figs. 1 and 3.) The signatures on the left-hand side of the figure were obtained for a different flight (flight no. 14), on a different date, and for markedly different weather conditions than those on the right-hand side of the figure (flight no. 8). The surfaced weather conditions differed mainly in wind velocity and wind direction. The signatures on the right-hand side of the figure were obtained for wind velocites on the order of 28 knots (14.4 m/sec) with gusts, whereas the signatures on the left-hand side of the figure were obtained for lower wind velocities. A much wider variation in the signature shapes exists for the condition of high winds. The main distortions of the waves in each case are associated with the rapidly rising portions of the boom signatures, and these distortions are of the same general nature as has been previously observed for other airplanes and for other test conditions. (See refs. 1, 2, and 3.)



(a) Flight 14. (b) Flight 8.

Figure 5.- Sonic-boom pressure-time histories showing wave-shape variations between microphones, as obtained at station 3 for two flights of bomber airplane during Chicago area measurements.

Some additional information on the wave-shape-variation results is given in figure 6. The included data are from the five different measuring stations which are separated by about a 15-nautical-mile (27 780-m) distance and spread over a 150-square-mile (388.5-km^2) area. Selected signatures are presented from one of the microphones at each station and data for the same two flights used in figure 5 are given for comparison. The signatures on the left-hand side of figure 6 are generally consistent in shape and are of the N-wave type. On the day these measurements were made, generally smooth signatures were obtained at all microphone locations in the test area. On the other hand, the data on the right-hand side of figure 6 are for the same microphones for a different flight on a different day and they show wide variations in signature shape. For the conditions of this latter flight, signature distortion occurred generally at all microphone locations, even though the manner in which the waves were distorted varied markedly from one measuring point to another.



(a) Flight 14. (b) Flight 8.

Figure 6.- Sonic-boom pressure-time histories showing wave-shape variations between stations, as obtained from one microphone at each of the five measuring stations for two flights of the bomber airplane during Chicago area measurements.

The results of figures 5 and 6 suggest a general correlation between the extent of a wide area on the ground and wave-shape distortion. It follows that wave-shape distortion or lack of distortion did not occur as a localized phenomenon but seemed to result from a general atmospheric condition which existed over a wide area at the time the tests were made. Experience has indicated that the atmospheric conditions can change sufficiently in a 2-hour period so that either or both types of results indicated in figures 5 and 6 might be encountered on a particular day. The highest overpressures were associated with peaked signatures and the lowest overpressures, with rounded-type signatures.

Tabulation of Data

The measured data as determined from time-history records such as those of figures 4, 5, and 6 are listed in table IV. The data in each section of the table are listed chronologically along with the airplane flight conditions. Peak overpressures, positive impulses, positive time durations, and wave-shape categories are listed for each microphone at each measuring station. Where there are no entries in the table, either the data did not exist or could not be properly interpreted.

Statistical Variations

Chicago area data.- The data of table IV have been analyzed to determine the manner in which peak-overpressure and peak-impulse values vary. The results of these studies are presented in figures 7 and 8. In order to obtain a larger statistical sample of data, the measurements at all stations except station 1 were combined; therefore, data are included for the ground track and also for a distance of about 3 miles on each side of the ground track. In each figure, the ratio of measured values to calculated values of either overpressure or impulse is plotted on the abscissa scale. The measured values of overpressure or positive impulse for any particular flight may be obtained from table IV and the calculated values along the ground track of the airplane, from table III. Also shown in each figure is an insert sketch (histogram) showing probability of occurrence of various values of the abscissa quantity.

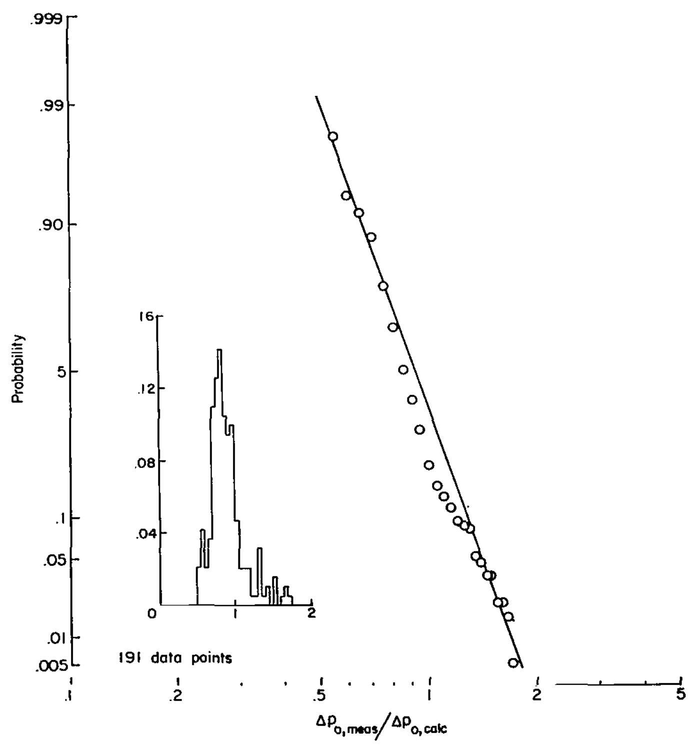


Figure 7.- Probability of equaling or exceeding a given value of the ratio of measured to calculated overpressures for the bomber airplane, as obtained during the Chicago area measurements.

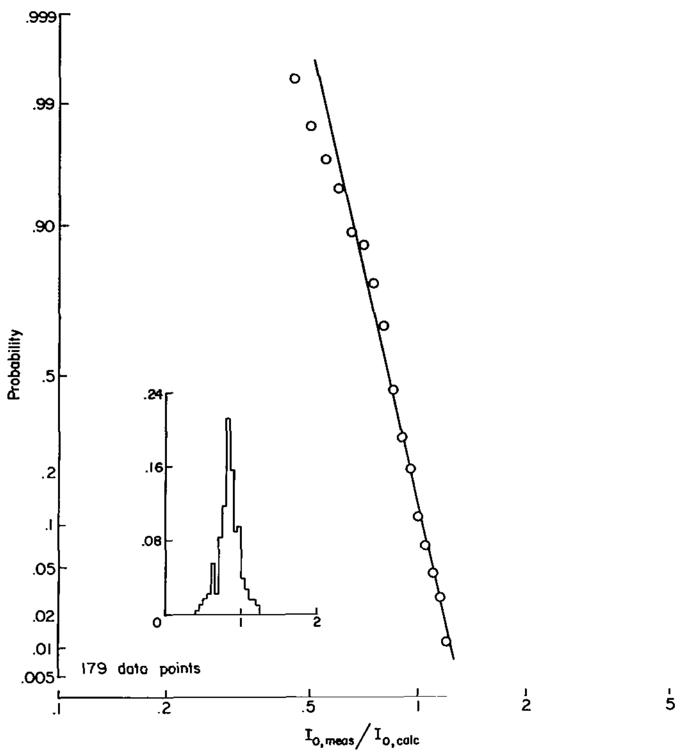


Figure 8.- Probability of equaling or exceeding a given value of the ratio of measured to calculated positive impulse for the bomber airplane, as obtained during the Chicago area measurements.

In figures 7 and 8, the data have been plotted as relative cumulative frequency distributions; and thus, the probability of equaling or exceeding the values given on the abscissa scale is shown on the ordinate scale. All data have been plotted on log normal paper and straight lines have been faired through the data points as an aid in interpretation. For this type of presentation, the data points would all fall on a straight line if the logarithm of the data fitted a normal distribution. The figures suggest that the data points seem to follow approximately a log normal distribution and also that the variations in the impulse data are generally less than the variations in the overpressure data. These results are in general agreement with the findings of reference 1.

Edwards Air Force Base area data.- Note that the data of figures 7 and 8 apply to a series of tests for which the weather conditions at least on the surface were relatively turbulent (based on the climatological data of table I and on the observations of the microphone station operators). In contrast to these conditions, data from the Edwards Air Force Base area apply to tests (data of ref. 2) for which the weather was relatively calm and quiescent and the signatures obtained were generally clean N-waves of the type shown in the left-hand side of figure 6. These data samples from the 20 flights at Edwards are presented in figures 9 and 10. Both the overpressure and the impulse data show less variation than the corresponding data of figures 7 and 8.

Combined measurements.- The data from both the Chicago area and Edwards Air Force Base area (ref. 2) are plotted along with 24 data samples from operations in the Oklahoma City area (ref. 1) and eight data samples from the operations in the St. Louis area (ref. 4). These composite data plots which refer to the same type of airplane are shown in figures 11 and 12 for the overpressures and the impulses, respectively. The variations indicated in these figures, which are noted to fall between those variations shown in figures 7 to 10, are for a wide range of atmospheric conditions. Data are included for temperatures ranging from about 3° to approximately 95° F (257° to

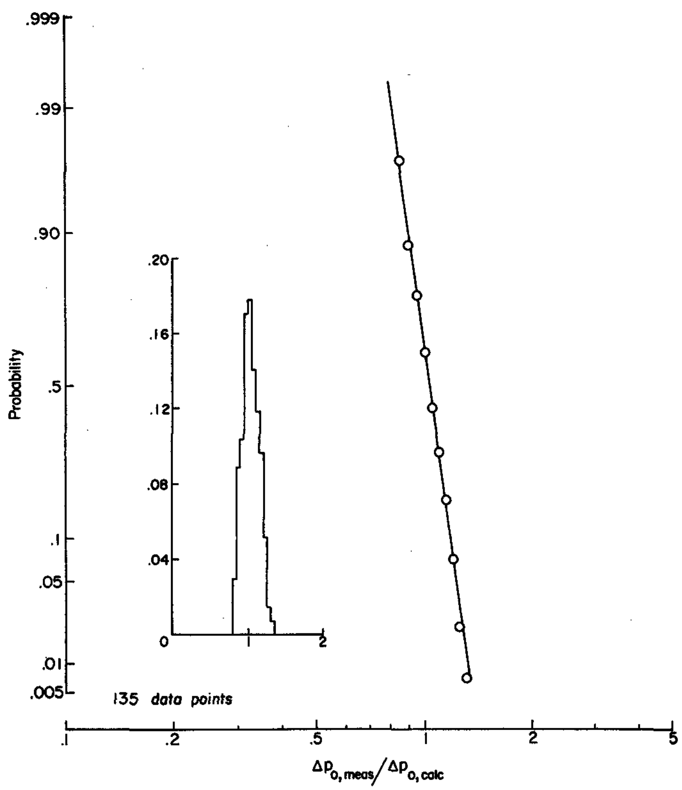


Figure 9.- Probability of equaling or exceeding a given value of the ratio of measured to calculated overpressures for the bomber airplane, as obtained during the Edwards area measurements.

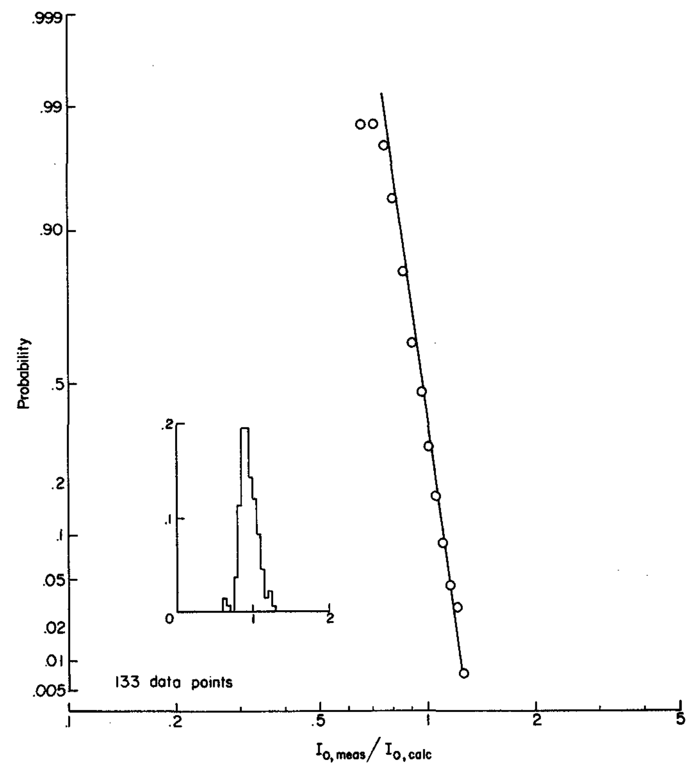


Figure 10.- Probability of equaling or exceeding a given value of the ratio of measured to calculated positive impulse for the bomber airplane, as obtained during the Edwards area measurements.

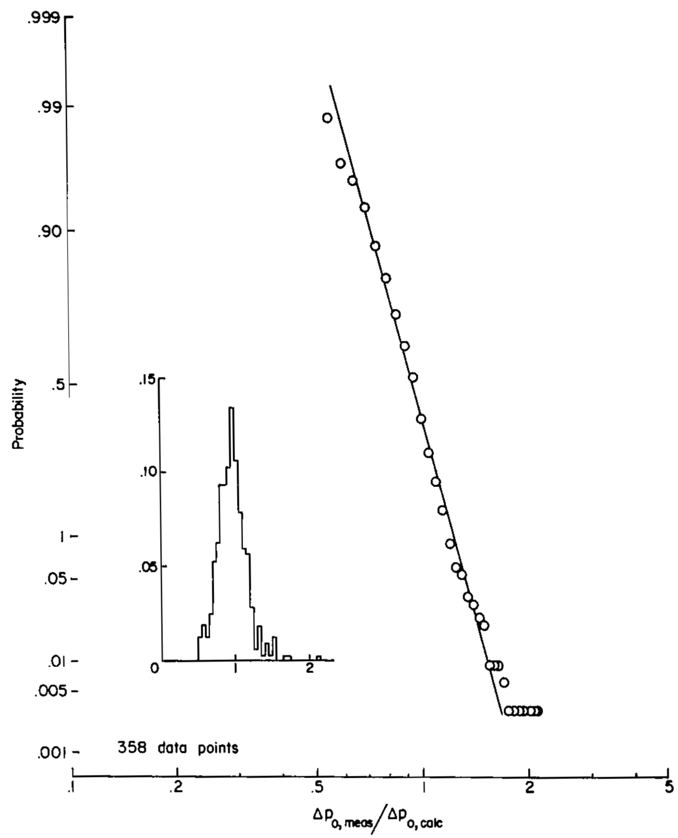


Figure 11.- Probability of equaling or exceeding a given value of the ratio of measured to calculated overpressures for the bomber airplane, as obtained during the Chicago area, Edwards area, St. Louis area, and Oklahoma City area measurements.

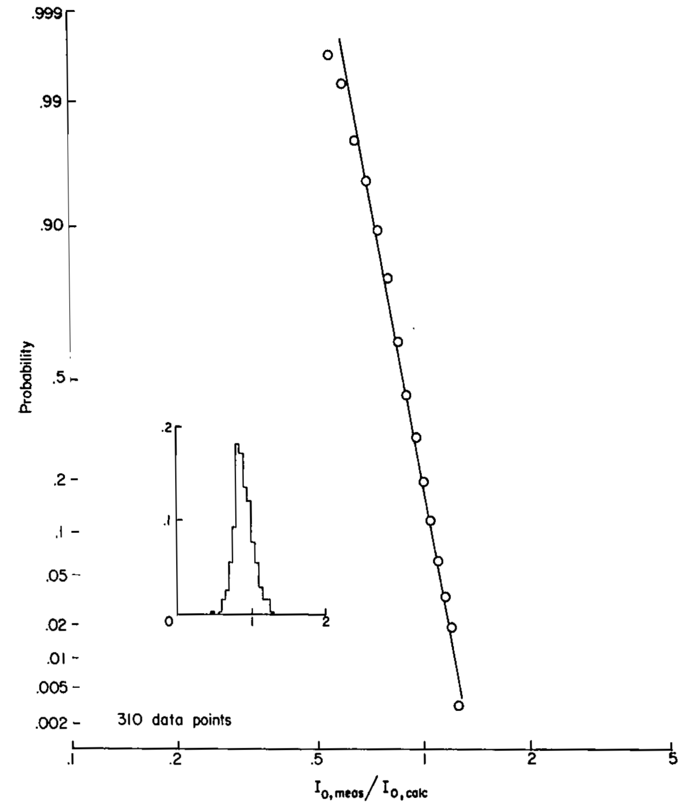


Figure 12.- Probability of equaling or exceeding a given value of the ratio of measured to calculated positive impulse for the bomber airplane, as obtained during the Chicago area, Edwards area, St. Louis area, and Oklahoma City area measurements.

approximately 308.2^{o} K) for quiescent as well as turbulent atmospheric conditions and for calm as well as gusty wind conditions.

Effect of sonic-boom-signature length.- In figures 13 and 14 the composite-data curves from figures 11 and 12 are compared, respectively, with similar on-the-track composite-data curves for the smaller fighter-type airplanes of reference 1. Figures 13 and 14 show that the variations in overpressure and impulses for the longer wave lengths of the bomber airplane are only slightly less than the variations for the fighter airplanes which produced shorter wave lengths.

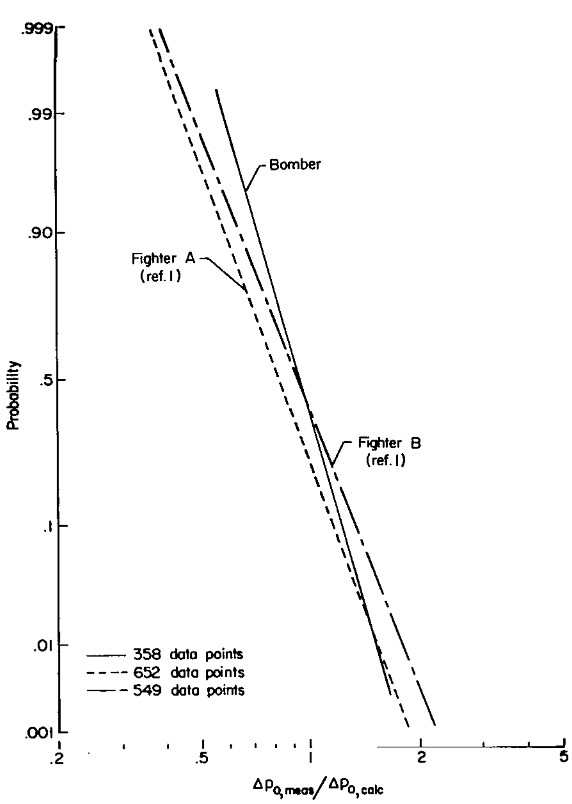


Figure 13.- Probability of equaling or exceeding a given value of the ratio of measured to calculated overpressures for the fighter airplanes and the bomber airplane.

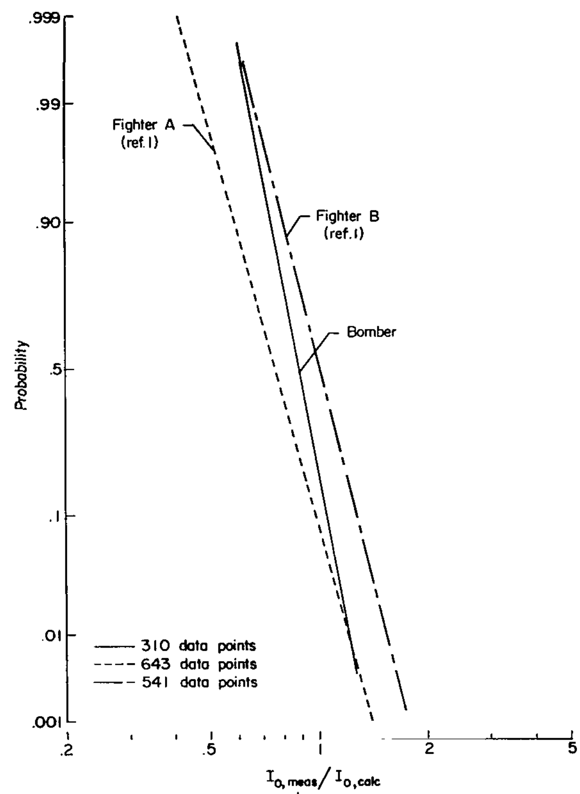


Figure 14.- Probability of equaling or exceeding a given value of the ratio of measured to calculated positive impulse for the fighter airplanes and the bomber airplane.

CONCLUDING REMARKS

Measurements have been made with the aid of bomber airplanes in an attempt to show the significance of atmospheric effects on the sonic-boom pressure signatures.

The measured sonic-boom signatures were noted to vary widely in both peak amplitude and wave shape because of atmospheric dynamic effects. The distortions were associated with the rapidly rising portions (bow and tail wave) of the boom signatures. The highest overpressures were associated with peaked signatures and the lowest overpressures, with rounded-type signatures. The variations of the overpressures and impulses may be represented over a significant range by log normal distributions, the overpressures having a markedly wider range of variations than the impulses. From the data evaluated to date similar variations in pressure signatures are noted for the shorter wave lengths produced by fighter airplanes and for the longer wave lengths produced by bomber airplanes.

Langley Research Center,
National Aeronautics and Space Administration,
Langley Station, Hampton, Va., July 19, 1966.

APPENDIX

SONIC-BOOM COMPLAINTS AND CLAIMS ARISING FROM FLIGHTS IN THE CHICAGO, ILLINOIS, AREA DURING THE PERIOD JANUARY 4 TO MARCH 31, 1965

The following information was obtained from the Office of the Judge Advocate General, U.S. Air Force, and is a brief summary of the complaints and claims activity in the Chicago, Illinois, area associated with supersonic flights of the type for which sonic-boom overpressure data are presented in this paper. Note that the overpressure data relate to 22 of the flights, whereas the following complaints and claims data pertain to the entire 49 supersonic flights of the training program.

Category	Number of complaints received	Number of claims received	Number of claims approved	Payments approved
Glass	3,383	1,788	1,150	$ 92,892
Plaster	2,654	623	163	16,600
Damage to structures	85	165*	15	1,517
Personal injury	18	1	0	0
Miscellaneous	976	387	114	3,754
TOTAL	7,116	2,964	1,442	$114,763

*These claims were originally classified as plaster damage; however, upon investigation they were reclassified as structural damage.

The values in the preceding table are only approximate and the claims data, in particular, relate only to those of $1,000 or under. Approval to pay these claims by the U.S. Air Force does not necessarily constitute validation of sonic-boom induced damage.

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TABLE I.- SUMMARY OF BOMBER OPERATING CONDITIONS AND CLIMATOLOGICAL DATA FROM CHICAGO SONIC-BOOM FLIGHTS

Date	Flight	Local time, hr	Operating conditions: Altitude, ft	Altitude, m	Mach number	Magnetic heading, deg	Lateral distance overhead, n. mi.	Lateral distance overhead, m	Airplane weight overhead, lb	Airplane weight overhead, kg	Climatological data: Surface temperature, °F	Surface temperature, °K	Surface winds, Knots	Surface winds, m/sec	Cloud cover	Precipitation
2- 2-65	1	1400	43 000	13 106	1.65	190	3.7W	6852	97 000	43 998	3	257.0	260/17	260/8.7	○	None
	2	1502	47 000	14 326	1.65	197	3.9W	7223	95 400	43 273	3	257.0	260/17	260/8.7	○	None
2- 3-65	3	1359	47 000	14 326	1.65	198	0.8W	1482	95 000	43 091	8	259.8	250/13	250/6.7	○	None
2- 4-65	4	1357	47 000	14 326	1.53	189	0.4W	741	91 000	41 277	9	260.4	250/9	250/4.6	⦶	None
2- 5-65	5	1359	46 800	14 265	1.63	194	2.8W	5185	99 000	44 906	44	279.8	217/23	217/11.8	⦶	None
2-10-65	6	1330	46 300	14 112	1.65	195	2.7W	5000	95 200	43 182	38	276.5	270/22	270/11.3	⦷	None
2-12-65	7	1231	48 000	14 630	1.43	197	2.3E	4260	98 000	44 452	23	268.1	260/28	260/14.4	⊕	-S
	8	1360	43 000	13 106	1.35	194	1.1W	2037	105 000	47 627	24	268.7	260/28	260/14.4	⊕	-S
2-17-65	9	1343	46 000	14 021	1.43	194	2.5W	4630	104 000	47 174	41	278.1	240/19	240/9.8	○	None
	10	1546	46 000	14 021	1.66	196	3.2W	5926	92 000	41 730	44	279.8	240/14	240/7.2	○	None
2-18-65	11	1303	46 200	14 082	1.65	195	2.4W	4445	100 500	45 586	38	276.5	230/8	230/4.1	⊕	None
2-19-65	12	1428	47 000	14 326	1.50	205	0.8W	1482	97 000	43 998	27	270.4	002/12	002/6.2	⦶	None
	13	1529	47 000	14 326	1.65	197	2.6W	4815	88 200	40 007	28	270.9	320/7	320/3.6	⦷	None
2-23-65	14	1345	47 000	14 326	1.65	198	2.6W	4815	103 000	46 720	20	266.5	090/13	090/6.7	⊕	-S
	15	1545	47 000	14 326	1.65	192	----	----	--- ---	-- ---	20	266.5	070/18	070/9.3	⊕	-S
2-24-65	16	1346	47 000	14 326	1.57	196	2.3W	4260	100 000	45 359	24	268.7	030/15	030/7.7	⊕	-S
	17	1545	47 000	14 326	1.66	190	3.6W	6667	103 000	46 720	24	268.7	030/20	030/10.3	⊕	-S
3- 2-65	18	1231	47 000	14 326	1.65	195	0.4W	741	94 400	42 819	37	275.9	050/11	050/5.7	⊕	R
3- 9-65	19	1230	47 000	14 326	1.65	191	----	----	98 000	44 452	33	273.7	310/19	310/9.8	⊕	-S
3-10-65	20	1230	47 000	14 326	1.65	193	----	----	--- ---	-- ---	30	272.0	330/13	330/6.2	⦷	None
3-11-65	21	1401	41 000	12 497	1.30	187	3.5W	6482	99 400	45 087	33	273.7	200/10	200/5.1	⊕	None
3-12-65	22	1236	38 000	11 582	1.20	193	2.5W	4630	102 500	46 493	37	275.9	350/13	350/6.7	⦷	None

TABLE II.- SYNOPTIC DATA OF WIND DIRECTION, WIND SPEED, AND TEMPERATURE AT VARIOUS ALTITUDES ON DAYS OF SONIC-BOOM FLIGHTS

(a) Wind direction and speed

		Wind direction on –		Wind speed, knots on –		Wind direction on –		Wind speed, knots on –		Wind direction on –		Wind speed, knots on –		Wind direction on –		Wind speed, knots on –		Wind direction on –		Wind speed, knots on –		Wind direction on –		Wind speed, knots on –		Wind direction on –		Wind speed, knots on –		Wind direction on –		Wind speed, knots on –	
Altitude		2-2-65 at –				2-3-65 at –				2-4-65 at –				2-5-65 at –				2-10-65 at –				2-12-65 at –				2-17-65 at –				2-18-65 at –			
ft	m	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr
500	152	270	270	5	5	280	260	10	10	300	230	15	5	210		20		230		25		250		20		280	260	10	20	280	300	10	20
4 600	1 402	280	280	20	30	280	280	30	35	300	280	30	20	270		50		240		50		240		30		270	280	35	35	290	290	35	25
9 500	2 896	280	290	25	30	280	290	50	60	300	290	35	40	300		40		240		60		230		60		270	280	40	50	290	310	65	60
18 000	5 486	280	300	35	65	290	290	70	80	310	290	70	50	290		60		240		90		230		70		270	270	80	80	280	280	70	100
23 000	7 010	280	300	50	70	280	280	100	110	300	300	80	110	300		55		240		100		230		100		260	270	100	80	300	270	100	100
29 000	8 839	280	300	60	80	290	280	120	100	310	300	100	120	300		60		240		110		230		110		260	270	140	80	280	280	100	130
38 000	11 582	280	300	70	85	290	280	100	100	320	300	90	100	300		100		240		90		230		75		260	270	110	90	280	280	90	80
44 000	13 411	280	280	60	70	280	280	60	100	310	290	80	75	300		70		240		70		230		80		250	270	90	60	270	280	100	50
52 000	15 850	280	270	40	60	290	280	60	70	300	280	60	65	300		50		240		50		230		40		250	270	70	60	270	270	65	50
Altitude		2-19-65 at –				2-23-65 at –				2-24-65 at –				3-2-65 at –				3-9-65 at –				3-10-65 at –				3-11-65 at –				3-12-65 at –			
ft	m	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr
500	152	360		10		130	140	10	10	50		10		90		10		320	290	5	15	310	330	15	10	250	220	5	10	340		10	
4 600	1 402	330		30		260	140	10	10	50		5		150		30		260	310	5	20	310	320	20	20	290	310	20	15	20		10	
9 500	2 896	330		40		270	220	40	60	250		15		150		30		260	310	20	30	310	340	30	20	300	300	30	20	320		15	
18 000	5 486	330		100		270	230	80	60	240		60		160		20		280	300	70	50	310	320	50	50	290	290	35	40	300		40	
23 000	7 010	320		130		280	240	100	70	230		60		160		20		300	280	60	70	310	320	60	55	300	280	55	60	290		70	
29 000	8 839	320		110		280	240	130	85	250		80		200		40		300	280	50	70	310	300	60	60	300	280	80	80	300		90	
38 000	11 582	320		80		270	240	80	90	260		70		220		35		290	280	30	60	310	300	50	50	280	290	70	80	310		90	
44 000	13 411	300		45		270	230	75	65	240		80		230		30		300	280	30	50	300	300	50	40	300	290	65	55	300		50	
52 000	15 850	300		40		260	250	80	70	240		70		250		20		300	280	20	30	300	300	30	30	280	280	40	10	300		40	

TABLE II.- SYNOPTIC DATA OF WIND DIRECTION, WIND SPEED, AND TEMPERATURE AT VARIOUS ALTITUDES ON DAYS OF SONIC-BOOM FLIGHTS – Concluded

(b) Temperature

Altitude, ft	Altitude, m	Temperature on – 2-2-65 at –		2-3-65 at –		2-4-65 at –		2-5-65 at –		2-10-65 at –		2-12-65 at –		2-17-65 at –		2-18-65 at –		2-19-65 at –		2-23-65 at –		2-24-65 at –		3-2-65 at –		3-9-65 at –		3-10-65 at –		3-11-65 at –		3-12-65 at –	
ft	m	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr	0600 hr	1800 hr
1 000	305	-2.2	-4.0	-7.6	-2.2	-4.0	6.8	19.4		42.8		23.0		21.2	33.8	19.4	32.0	15.8		-6.8	15.8	15.8		35.6		28.4	30.2	26.6	24.8	21.2	26.6	23.0	
2 000	610	-.4	-2.2	-4.0	-2.2	-.4	3.2	19.4		39.2		21.2		15.8	32.0	17.6	28.4	12.2		3.2	12.2	12.2		35.6		24.8	24.8	21.2	21.2	21.2	19.4	21.2	
3 000	914	-.4	-.4	-.4	-2.2	-5.8	5.0	26.6		35.6		17.6		17.6	30.2	19.4	23.0	8.6		1.4	8.6	8.6		41.0		23.0	19.4	17.6	15.8	17.6	15.8	17.6	
4 000	1 219	-5.8	1.4	-2.2	-.4	-2.2	6.8	35.6		32.0		19.4		21.2	28.4	23.0	17.6	8.6		3.2	8.6	10.4		39.2		17.6	10.4	12.2	10.4	15.8	15.8	14.0	
5 000	1 524	-7.6	3.2	-4.0	1.4	1.4	8.6	41.0		28.4		23.0		21.2	26.6	24.8	15.8	8.6		5.0	8.6	6.8		37.4		14.0	5.0	6.8	8.6	15.8	15.8	15.8	
6 000	1 829	-5.8	1.4	-5.8	-2.2	3.2	10.4	37.4		30.2		24.8		17.6	24.8	21.2	14.0	10.4		6.8	8.6	15.8		33.8		10.4	5.0	5.0	6.8	12.2	14.0	17.6	
7 000	2 134	-4.0	-2.2	-9.4	-4.0	1.4	12.2	35.6		30.2		21.2		14.0	21.2	17.6	14.0	8.6		8.6	10.4	15.8		32.0		6.8	5.0	5.0	5.0	10.4	12.2	14.0	
8 000	2 438	-2.2	-5.8	-13.0	-5.8	-.4	12.2	32.0		30.2		17.6		12.2	17.6	14.0	12.2	6.8		6.8	10.4	14.0		28.4		3.2	5.0	3.2	3.2	8.6	10.4	12.2	
9 000	2 743	-7.6	-9.4	-14.8	-7.6	-4.0	10.4	28.4		26.6		14.0		8.6	14.0	12.2	10.4	6.8		5.0	12.2	10.4		24.8		1.4	5.0	3.2	1.4	5.0	8.6	10.4	
10 000	3 048	-11.2	-13.0	-16.6	-9.4	-5.8	8.6	24.8		23.0		12.2		6.8	14.0	10.4	8.6	5.0		3.2	8.6	8.6		23.0		-2.2	1.4	-.4	-.4	1.4	5.0	6.8	
12 000	3 658	-18.4	-18.4	-23.8	-13.0	-11.2	3.2	19.4		15.8		3.2		1.4	8.6	6.8	3.2	3.2		-.4	3.2	3.2		15.8		-9.4	-5.8	-7.6	-5.8	-4.0	-.4	1.4	
14 000	4 267	-23.8	-25.6	-31.0	-16.6	-16.6	-2.2	12.2		8.6		-2.2		-4.0	-.4	1.4	-2.2	1.4		-4.0	-.4	-.4		10.4		-16.6	-13.0	-13.0	-9.4	-9.4	-5.8	-.4	
16 000	4 877	-31.0	-31.0	-36.4	-25.6	-22.0	-7.6	5.0		3.2		-9.4		-9.4	-7.6	-4.0	-7.6	-4.0		-7.6	-5.8	-5.8		5.0		-22.0	-18.4	-20.2	-13.0	-14.8	-11.2	-7.6	
18 000	5 486	-38.2	-38.2	-40.0	-34.6	-25.6	-11.2	-2.2		-2.2		-16.6		-14.8	-14.8	-9.4	-13.0	-9.4		-11.2	-9.4	-9.4		-2.2		-27.4	-25.6	-25.6	-18.4	-20.2	-20.2	-14.8	
20 000	6 096	-45.4	-45.4	-45.4	-40.0	-34.6	-22.0	-11.2		-4.0		-23.8		-22.0	-23.8	-20.2	-20.2	-14.8		-20.2	-18.4	-16.6		-11.2		-36.4	-32.8	-32.8	-27.4	-27.4	-25.6	-23.8	
22 000	6 706	-50.8	-52.6	-49.0	-45.4	-43.6	-31.0	-18.4		-11.2		-29.2		-29.2	-34.6	-29.2	-27.4	-22.0		-31.0	-27.4	-23.8		-18.4		-43.6	-40.0	-40.0	-36.4	-34.6	-32.8	-32.8	
24 000	7 315	-56.2	-58.0	-52.6	-50.8	-45.4	-38.2	-25.6		-18.4		-34.6		-36.4	-45.4	-40.0	-36.4	-29.2		-38.2	-36.4	-32.8		-27.4		-50.8	-45.4	-47.2	-45.4	-43.6	-40.0	-41.8	
26 000	7 925	-56.2	-56.2	-52.6	-58.0	-50.8	-47.2	-36.4		-25.6		-41.8		-43.6	-54.4	-49.0	-43.6	-38.2		-49.0	-45.4	-41.8		-36.4		-56.2	-54.4	-54.4	-52.6	-52.6	-49.0	-49.0	
28 000	8 534	-54.4	-56.2	-54.4	-63.4	-54.4	-56.2	-45.4		-32.8		-47.2		-50.8	-63.4	-58.0	-52.6	-37.2		-58.0	-54.4	-50.8		-45.4		-61.6	-61.6	-61.6	-59.8	-59.8	-56.2	-58.0	
30 000	9 144	-54.4	-54.4	-56.2	-63.4	-59.8	-63.4	-52.6		-41.8		-52.6		-58.0	-65.2	-67.0	-63.4	-54.4		-68.8	-63.4	-59.8		-54.4		-59.8	-59.8	-65.2	-67.0	-61.6	-61.6	-59.8	
32 000	9 754	-52.6	-54.4	-56.2	-61.6	-65.2	-70.6	-61.6		-50.8		-59.8		-65.2	-63.4	-67.0	-70.6	-59.8		-77.8	-72.4	-67.0		-63.4		-58.0	-56.2	-61.6	-63.4	-59.8	-59.8	-58.0	
34 000	10 363	-40.0	-52.6	-54.4	-59.8	-67.0	-79.6	-70.6		-61.6		-59.8		-63.4	-61.6	-67.0	-76.0	-68.8		-79.6	-77.8	-76.0		-72.4		-56.2	-56.2	-59.8	-61.6	-58.0	-58.0	-56.2	
36 000	10 973	-50.8	-52.6	-54.4	-58.0	-67.0	-85.0	-79.6		-61.6		-58.0		-61.6	-59.8	-67.0	-72.4	-79.6		-76.0	-74.2	-85.0		-81.4		-56.2	-56.2	-59.8	-61.6	-59.8	-56.2	-54.4	
38 000	11 582	-52.6	-52.6	-54.4	-58.0	-65.2	-79.6	-88.6		-61.6		-58.0		-59.8	-61.6	-65.2	-70.6	-83.2		-74.2	-74.2	-81.4		-77.8		-54.4	-56.2	-59.8	-59.8	-59.8	-56.2	-54.4	
40 000	12 192	-52.6	-52.6	-56.2	-58.0	-63.4	-76.0	-85.0		-61.6		-58.0		-61.6	-63.4	-67.0	-68.8	-81.4		-70.6	-74.2	-76.0		-74.2		-56.2	-56.2	-58.0	-59.8	-59.8	-58.0	-56.2	
42 000	12 802	-54.4	-54.4	-56.2	-58.0	-63.4	-74.2	-81.4		-63.4		-59.8		-63.4	-63.4	-67.0	-67.0	-77.8		-68.8	-74.2	-74.2		-72.4		-56.2	-56.2	-58.0	-59.8	-61.6	-59.8	-58.0	
44 000	13 411	-54.4	-56.2	-58.0	-59.8	-63.4	-72.4	-77.8		-63.4		-61.6		-65.2	-65.2	-68.8	-67.0	-76.0		-70.6	-72.4	-72.4		-72.4		-58.0	-58.0	-58.0	-58.0	-63.4	-59.8	-59.8	
46 000	14 021	-56.2	-58.0	-59.8	-59.8	-63.4	-72.4	-77.8		-67.0		-63.4		-67.0	-67.0	-68.8	-68.8	-74.2		-72.4	-70.6	-74.2		-72.4		-58.0	-58.0	-59.8	-58.0	-63.4	-61.6	-61.6	
48 000	14 630	-58.0	-59.8	-59.8	-61.6	-63.4	-70.6	-77.8		-68.8		-65.2		-67.0	-68.8	-70.6	-68.8	-74.2		-74.2	-68.8	-74.2		-72.4		-61.6	-61.6	-59.8	-58.0	-63.4	-61.6	-61.6	
50 000	15 240	-59.8	-59.8	-61.6	-61.6	-65.2	-70.6	-77.8		-74.2		-67.0		-68.8	-70.6	-70.6	-76.0	-72.4		-74.2	-67.0	-74.2		-74.2		-61.6	-63.4	-59.8	-58.0	-63.4	-63.4	-63.4	

TABLE III. - SUMMARY OF NOMINAL VALUES OF OVERPRESSURE AND POSITIVE IMPULSE ALONG GROUND TRACK OF BOMBER AIRPLANE FOR VARIOUS FLIGHT CONDITIONS OF THE CHICAGO AREA, ST. LOUIS AREA, OKLAHOMA CITY AREA, AND EDWARDS, CALIFORNIA, AREA EXPERIMENTS

Mach number	Altitude		Airplane weight overhead		Nominal overpressure		Nominal positive impulse	
	ft	m	lb	kg	lb/ft^2	N/m^2	lb-sec/ft^2	N-sec/m^2
1.5	29 000	8 839	70 400	31 933	2.76	132	0.1117	5.35
1.2	38 000	11 583	102 500	46 493	1.90	91.0	.0963	4.61
1.85	39 000	11 888	79 900	36 242	2.07	99.1	.0938	4.49
1.80	39 900	12 162	89 200	40 460	2.01	96.2	.0935	4.48
1.3	41 000	12 497	99 400	45 087	1.76	84.3	.0880	4.21
1.65	43 000	13 107	97 000	43 998	1.82	87.1	.0882	4.22
1.43	46 000	14 021	104 000	47 174	1.63	78.0	.0875	4.19
1.66	46 000	14 021	92 000	41 730	1.78	85.2	.0953	4.56
1.63	46 800	14 265	99 000	44 906	1.62	77.6	.0827	3.96
1.65	47 000	14 326	96 500	43 771	1.62	77.6	.0829	3.97
1.96	47 500	14 478	74 800	33 929	1.63	78.0	.0841	4.03
1.43	48 000	14 631	98 000	44 452	1.52	72.8	.0827	3.96
2.00	49 400	15 058	85 200	38 646	1.59	76.1	.0861	4.12
2.00	58 900	17 953	85 000	38 555	1.27	60.8	.0804	3.85
2.00	59 100	18 014	64 000	29 030	1.17	56.0	.0685	3.28
1.95	59 300	18 075	70 980	32 196	1.20	57.5	.0731	3.50
2.00	59 300	18 075	83 800	38 011	1.29	61.8	.0836	4.00
2.00	59 900	18 258	82 280	37 321	1.24	59.4	.0792	3.79
1.96	60 200	18 350	65 930	29 905	1.13	54.1	.0670	3.21
2.00	60 800	18 532	74 780	33 919	1.17	56.0	.0731	3.50
2.00	63 100	19 234	66 780	30 291	1.06	50.8	.0657	3.14
1.97	63 400	19 325	70 800	32 114	1.13	54.1	.0756	3.62
1.72	68 500	20 879	67 700	30 708	1.01	48.4	.0759	3.63
1.60	69 800	21 276	83 200	37 739	1.03	49.3	.0857	4.10
1.65	72 500	22 099	71 200	32 296	.99	47.4	.0874	4.18

TABLE IV.- SUMMARY OF CHICAGO SONIC-BOOM DATA FOR BOMBER AIRPLANE

(a) Peak overpressures, Δp_o, lb/ft^2

Date	Flight	Local time, hr	Operating conditions: Altitude, ft	Operating conditions: Mach number	Peak overpressures, Δp_o, lb/ft^2 for – Station 1 at – Mike 1	Station 1 at – Mike 2	Station 2 at – Mike 1	Station 2 at – Mike 2	Station 3 at – Mike 1	Station 3 at – Mike 2	Station 3 at – Mike 3	Station 3 at – Mike 4	Station 3 at – Mike 5	Station 4 at – Mike 1	Station 4 at – Mike 2	Station 5 at – Mike 1	Station 5 at – Mike 2
2- 2-65	1	1400	43 000	1.65	1.04	1.05	----	----	-----	-----	-----	-----	-----	----	----	----	----
	2	1502	47 000	1.65	1.15	1.34	----	----	-----	-----	-----	-----	-----	----	----	----	----
2- 3-65	3	1359	47 000	1.65	0.85	0.86	1.08	1.03	-----	-----	-----	-----	-----	----	----	----	----
2- 4-65	4	1357	47 000	1.53	0.92	1.05	----	----	-----	-----	-----	-----	-----	1.64	1.53	----	----
2- 5-65	5	1359	46 800	1.63	1.08	1.03	1.70	1.59	2.31	2.78	-----	-----	-----	1.59	1.55	----	----
2-10-65	6	1330	46 300	1.65	0.68	0.77	1.33	1.31	1.52*	1.58*	-----	1.48*	1.38*	1.20	1.21	----	----
2-12-65	7	1231	48 000	1.43	0.70	0.73	2.53	2.49	1.61*	1.52*	1.54*	1.44*	1.59*	1.27	1.43	1.83	1.87
	8	1360	43 000	1.35	1.59	1.74	2.38	2.44	2.73	2.57	2.15	1.74	2.18	2.12	1.99	1.56	1.62
2-17-65	9	1343	46 000	1.43	0.60	0.75	0.83	0.84	1.37	1.37	1.60	1.35	1.12	----	----	1.70	1.78
	10	1546	46 000	1.66	0.97	1.14	1.33	1.55	1.63	1.70	2.16	2.18	1.66	1.28	1.32	2.08	2.17
2-18-65	11	1303	46 200	1.65	0.83	1.02	1.18	1.17	2.26	1.56	2.81	1.30	1.52	1.46	1.36	1.18	1.21
2-19-65	12	1428	47 000	1.50	0.92	0.93	1.62	1.55	1.85	1.52	1.26	1.45	1.60	1.16	1.05	1.49	1.42
	13	1529	47 000	1.65	1.02	1.38	1.19	1.18	1.58	1.36	1.26	1.35	1.50	1.36	1.26	2.02	1.87
2-23-65	14	1345	47 000	1.65	1.35	1.44	1.56	1.69	1.66	1.32	1.45	1.46	1.39	1.37	1.35	1.36	1.28
	15	1545	47 000	1.65	0.79	0.97	1.62	1.58	1.33	1.40	1.24	1.34	1.25	1.43	1.35	1.32	1.24
2-24-65	16	1346	47 000	1.57	1.37	1.60	0.96	0.98	1.58	1.43	1.55	1.33	1.45	1.07	0.92	1.32	1.29
	17	1545	47 000	1.66	0.49	0.59	0.96	0.95	1.51	1.18	1.44	1.24	1.24	2.14	1.79	0.95	0.95
3- 2-65	18	1231	47 000	1.65	0.54	0.56	1.02	0.98	1.26	1.14	1.19	1.14	1.21	0.90	0.88	1.28	1.31
3- 9-65	19	1230	47 000	1.65	0.82	1.38	1.34	1.40	1.29	1.20	1.26	1.43	1.28	1.27	1.20	1.17	1.21
3-10-65	20	1230	47 000	1.65	----	----	1.19	1.12	1.62	1.41	1.63	1.35	1.79	1.71	1.68	1.50	1.51
3-11-65	21	1401	41 000	1.30	0.57	0.59	1.87	1.73	1.34	1.16	1.43	1.40	1.45	1.35	1.29	3.09	3.24
3-12-65	22	1236	38 000	1.20	1.27	1.36	1.57	1.66	1.66	1.55	1.51	1.50	1.54	1.82	1.65	----	----

*Microphones grouped for calibration purposes.

TABLE IV.- SUMMARY OF CHICAGO SONIC-BOOM DATA FOR BOMBER AIRPLANE – Continued

(b) Peak overpressures, Δp_o, N/m^2

Date	Flight	Local time, hr	Operating conditions		Peak overpressures, Δp_o, N/m^2 for –													
			Altitude, m	Mach number	Station 1 at –		Station 2 at –		Station 3 at –					Station 4 at –		Station 5 at –	
					Mike 1	Mike 2	Mike 1	Mike 2	Mike 1	Mike 2	Mike 3	Mike 4	Mike 5	Mike 1	Mike 2	Mike 1	Mike 2
2- 2-65	1	1400	13 106	1.65	49.8	50.3	-----	-----	------	------	------	------	------	-----	----	-----	-----
	2	1502	14 326	1.65	55.1	64.2	-----	-----	------	------	------	------	------	-----	----	-----	-----
2- 3-65	3	1359	14 326	1.65	40.7	41.2	51.7	49.3	------	------	------	------	------	-----	----	-----	-----
2- 3-65	4	1357	14 326	1.53	44.1	50.3	-----	-----	------	------	------	------	------	78.5	73.3	-----	-----
2- 5-65	5	1359	14 265	1.63	51.7	49.3	81.4	76.1	110.6	133.1	------	------	------	76.1	74.2	-----	-----
2-10-65	6	1330	14 112	1.65	32.6	36.9	63.7	62.7	72.8*	75.7*	------	70.9*	66.1*	57.5	57.9	-----	-----
2-12-65	7	1231	14 630	1.43	33.5	35.0	121.1	119.2	77.1*	72.8*	73.7*	69.0*	76.1*	60.8	68.5	87.6	89.5
	8	1360	13 106	1.35	76.1	83.3	114.0	116.8	130.7	123.1	102.9	83.3	104.4	101.5	95.3	74.7	77.6
2-17-65	9	1343	14 021	1.43	28.7	35.9	39.7	40.2	65.6	65.6	76.6	64.6	53.6	-----	----	81.4	85.2
	10	1546	14 021	1.66	46.4	54.6	63.7	74.2	78.0	81.4	103.4	104.4	79.5	61.3	63.2	99.6	103.9
2-18-65	11	1303	14 082	1.65	39.7	48.8	56.6	56.0	108.2	74.7	134.5	62.2	72.8	69.9	65.1	56.5	57.9
2-19-65	12	1428	14 326	1.50	44.1	44.5	77.6	74.2	88.6	72.8	60.3	69.4	76.6	55.5	50.3	71.3	68.0
	13	1529	14 326	1.65	48.8	66.1	57.0	56.5	75.7	65.1	60.3	64.6	71.8	65.1	60.3	96.7	89.5
2-23-65	14	1345	14 326	1.65	64.6	69.0	74.7	80.9	79.5	63.2	69.4	69.9	66.6	65.6	64.6	65.1	61.3
	15	1545	14 326	1.65	37.8	46.4	77.6	75.7	63.7	67.0	59.4	64.2	59.9	68.5	64.6	63.2	59.4
2-24-65	16	1346	14 326	1.57	65.6	76.6	46.0	46.9	75.7	68.5	74.2	63.7	69.4	51.2	44.1	63.2	61.8
	17	1545	14 326	1.66	23.5	28.9	46.0	45.5	72.3	56.5	69.0	59.4	59.4	102.5	85.7	45.5	45.5
3- 2-65	18	1231	14 326	1.65	25.9	26.8	48.8	46.9	60.3	54.6	57.0	54.6	57.9	43.1	42.1	61.3	62.7
3- 9-65	19	1230	14 326	1.65	39.3	66.1	64.2	67.0	61.8	57.5	60.3	68.5	61.3	60.8	57.5	56.0	57.9
3-10-65	20	1230	14 326	1.65	----	----	57.0	53.6	72.8	67.5	78.0	64.6	85.7	81.9	80.4	71.8	72.3
3-11-65	21	1401	12 497	1.30	27.3	28.3	89.5	82.8	64.2	55.5	68.5	67.0	69.4	64.6	61.8	148.0	155.1
3-12-65	22	1236	11 582	1.20	60.8	65.1	75.2	79.5	79.5	74.2	72.3	71.8	73.7	87.1	79.0	-----	-----

*Microphones grouped for calibration purposes.

TABLE IV.- SUMMARY OF CHICAGO SONIC-BOOM DATA FOR BOMBER AIRPLANE – Continued

(c) Positive impulse, I_o, lb-sec/ft^2

Date	Flight	Local time, hr	Operating conditions: Altitude, ft	Operating conditions: Mach number	Positive impulse, I_o, lb-sec/ft^2 for – Station 1 at – Mike 1	Station 1 at – Mike 2	Station 2 at – Mike 1	Station 2 at – Mike 2	Station 3 at – Mike 1	Station 3 at – Mike 2	Station 3 at – Mike 3	Station 3 at – Mike 4	Station 3 at – Mike 5	Station 4 at – Mike 1	Station 4 at – Mike 2	Station 5 at – Mike 1	Station 5 at – Mike 2
2- 2-65	1	1400	43 000	1.65	0.0515	0.0524	------	------	------	------	------	------	------	------	------	------	------
	2	1502	47 000	1.65	0.0711	0.0725	------	------	------	------	------	------	------	------	------	------	------
2- 3-65	3	1359	47 000	1.65	0.0490	0.0532	0.0675	0.0650	------	------	------	------	------	------	------	------	------
2- 4-65	4	1357	47 000	1.53	0.0620	0.0716	------	------	------	------	------	------	------	0.0847	0.0837	------	------
2- 5-65	5	1359	46 800	1.63	0.0537	0.0647	0.0865	0.0856	0.0653	0.0766	------	------	------	0.0630	0.0626	------	------
2-10-65	6	1330	46 300	1.65	0.0533	0.0609	0.0803	0.0819	0.0811	0.0797	------	0.0778	0.0737	0.0747	0.0762	------	------
2-12-65	7	1231	48 000	1.43	0.0647	0.0647	0.0925	0.0964	0.0862	0.0812	0.0850	0.0780	0.0893	0.0675	0.0643	0.0514	0.0489
	8	1360	43 000	1.35	0.0787	0.0868	0.1037	0.1068	0.0867	------	0.0941	0.0864	0.0998	0.1000	0.1061	0.0643	0.0614
2-17-65	9	1343	46 000	1.43	0.0395	0.0481	0.0761	0.0806	0.0702	0.0660	0.0732	0.0636	0.0750	------	------	0.0713	0.0744
	10	1546	46 000	1.66	0.0528	0.0588	0.0711	0.0755	0.0746	0.0655	0.0742	0.0688	0.0686	0.0697	0.0715	0.0550	0.0612
2-18-65	11	1303	46 200	1.65	0.0511	0.0610	0.0707	0.0676	0.0685	0.0686	0.1004	0.0684	0.0721	0.0663	0.0640	0.0427	0.0473
2-19-65	12	1428	47 000	1.50	0.0603	0.0638	0.0821	0.0812	0.0720	0.0758	0.0642	0.0748	0.0760	0.0678	0.0631	0.0519	0.0516
	13	1529	47 000	1.65	0.0587	0.0652	0.0749	0.0732	0.0783	0.0698	0.0620	0.0659	0.0742	0.0632	0.0578	0.0677	0.0504
2-23-65	14	1345	47 000	1.65	0.0720	0.0815	0.0785	0.0754	0.0758	0.0630	0.0680	0.0716	0.0684	0.0817	0.0793	------	------
	15	1545	47 000	1.65	0.0475	0.0572	0.0733	0.0746	0.0838	0.0783	0.0719	0.0744	0.0773	0.0686	0.0607	------	------
2-24-65	16	1346	47 000	1.57	0.0502	0.0588	0.0700	0.0661	0.0724	0.0701	0.0752	0.0644	0.0726	------	------	------	------
	17	1545	47 000	1.66	0.0289	0.0331	0.0681	0.0595	0.0867	0.0712	0.0808	0.0717	0.0826	------	------	------	------
3- 2-65	18	1231	47 000	1.65	0.0322	0.0323	0.0549	0.0545	0.0587	0.0616	0.0640	0.0667	0.0655	0.0589	0.0551	0.0451	0.0449
3- 9-65	19	1230	47 000	1.65	0.0424	0.0455	0.0787	0.0770	0.0681	0.0707	0.0713	0.0705	0.0765	0.0633	0.0602	0.0372	0.0405
3-10-65	20	1230	47 000	1.65	------	------	0.0780	0.0690	0.0690	0.0663	0.0717	0.0717	0.0741	0.0605	0.0647	0.0498	0.0516
3-11-65	21	1401	41 000	1.30	0.0483	0.0495	0.0872	0.0864	0.0808	0.0829	0.0828	0.0806	0.0795	0.0822	0.0837	0.0610	0.0601
3-12-65	22	1236	38 000	1.20	0.0683	0.0720	0.1043	0.0995	0.0960	0.0941	0.0953	0.0901	0.0945	0.1045	0.0997	------	------

TABLE IV.- SUMMARY OF CHICAGO SONIC-BOOM DATA FOR BOMBER AIRPLANE – Continued

(d) Positive impulse, I_o, N/m^2

Date	Flight	Local time, hr	Operating conditions		Positive impulse, I_o, N/m^2 for –													
			Altitude, m	Mach number	Station 1 at –		Station 2 at –		Station 3 at –					Station 4 at –		Station 5 at –	
					Mike 1	Mike 2	Mike 1	Mike 2	Mike 1	Mike 2	Mike 3	Mike 4	Mike 5	Mike 1	Mike 2	Mike 1	Mike 2
2- 2-65	1	1400	13 106	1.65	2.47	2.51	----	----	----	----	----	----	----	----	----	----	----
	2	1502	14 326	1.65	3.40	3.47	----	----	----	----	----	----	----	----	----	----	----
2- 3-65	3	1359	14 326	1.65	2.35	2.55	3.23	3.11	----	----	----	----	----	----	----	----	----
2- 4-65	4	1357	14 326	1.53	2.97	3.43	----	----	----	----	----	----	----	4.06	4.01	----	----
2- 5-65	5	1359	14 265	1.63	2.57	3.10	4.14	4.10	3.13	3.67	----	----	----	3.02	3.00	----	----
2-10-65	6	1330	14 112	1.65	2.55	2.92	3.85	3.92	3.88	3.82	----	3.73	3.53	3.58	3.65	----	----
2-12-65	7	1231	14 630	1.43	3.10	3.10	4.43	4.62	4.13	3.89	4.07	3.74	4.28	3.23	3.08	2.46	2.34
	8	1360	13 106	1.35	3.77	4.16	4.97	5.11	4.15	----	4.51	4.14	4.78	4.79	5.08	3.08	2.94
2-17-65	9	1343	14 021	1.43	1.89	2.30	3.64	3.86	3.36	3.16	3.51	3.05	3.59	----	----	3.41	3.56
	10	1546	14 021	1.66	2.53	2.82	3.40	3.62	3.57	3.14	3.55	3.29	3.29	3.34	3.42	2.63	2.93
2-18-65	11	1303	14 082	1.65	2.45	2.92	3.39	3.24	3.28	3.29	4.81	3.28	3.45	3.17	3.06	2.04	2.27
2-19-65	12	1428	14 326	1.50	2.89	3.06	3.93	3.89	3.45	3.63	3.07	3.58	3.64	3.25	3.02	2.49	2.47
	13	1529	14 326	1.65	2.81	3.12	3.59	3.51	3.75	3.34	2.97	3.16	3.55	3.03	2.77	3.24	2.41
2-23-65	14	1345	14 326	1.65	3.45	3.90	3.76	3.61	3.63	3.02	3.26	3.43	3.28	3.91	3.80	----	----
	15	1545	14 326	1.65	2.27	2.74	3.51	3.57	4.01	3.75	3.44	3.56	3.70	3.29	2.91	----	----
2-24-65	16	1346	14 326	1.57	2.40	2.82	3.35	3.17	3.47	3.36	3.60	3.08	3.48	----	----	----	----
	17	1545	14 326	1.66	1.38	1.59	3.26	2.85	4.15	3.41	3.87	3.43	3.96	----	----	----	----
3- 2-65	18	1231	14 326	1.65	1.54	1.55	2.63	2.61	2.81	2.95	3.06	3.19	3.14	2.82	2.64	2.16	2.15
3- 9-65	19	1230	14 326	1.65	2.03	2.18	3.77	3.69	3.26	3.39	3.41	3.38	3.66	3.03	2.88	1.78	1.94
3-10-65	20	1230	14 326	1.65	----	----	3.74	3.30	3.30	3.17	3.43	3.43	3.55	2.90	3.10	2.38	2.47
3-11-65	21	1401	12 497	1.30	2.31	2.37	4.18	4.14	3.87	3.97	3.96	3.86	3.81	3.94	4.01	2.92	2.88
3-12-65	22	1236	11 582	1.20	3.27	3.45	4.99	4.76	4.60	4.51	4.56	4.31	4.53	5.00	4.77	----	----

TABLE IV.- SUMMARY OF CHICAGO SONIC-BOOM DATA FOR BOMBER AIRPLANE – Continued

(e) Positive time duration, Δt_o, sec

Date	Flight	Local time, hr	Operating conditions: Altitude, ft	Altitude, m	Mach number	Positive time duration Δt_o, sec for – Station 1 at – Mike 1	Station 1 Mike 2	Station 2 at – Mike 1	Station 2 Mike 2	Station 3 at – Mike 1	Station 3 Mike 2	Station 3 Mike 3	Station 3 Mike 4	Station 3 Mike 5	Station 4 at – Mike 1	Station 4 Mike 2	Station 5 at – Mike 1	Station 5 Mike 2
2- 2-65	1	1400	43 000	13 106	1.65	0.099	0.093	-----	-----	-----	-----	-----	-----	-----	4	-----	-----	-----
	2	1502	47 000	14 326	1.65	0.112	0.104	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2- 3-65	3	1359	47 000	14 326	1.65	0.108	0.116	0.110	0.112	-----	-----	-----	-----	-----	-----	-----	-----	-----
2- 4-65	4	1357	47 000	14 326	1.53	0.111	0.110	-----	-----	-----	-----	-----	-----	-----	0.090	0.094	-----	-----
2- 5-65	5	1359	46 800	14 265	1.63	0.105	0.116	0.110	0.120	0.071	0.078	-----	-----	-----	0.094	0.096	-----	-----
2-10-65	6	1330	46 300	14 112	1.65	0.128	0.125	0.122	0.120	0.103	0.103	-----	0.103	0.103	0.106	0.106	-----	-----
2-12-65	7	1231	48 000	14 630	1.43	0.145	0.145	0.102	0.105	0.113	0.113	0.113	0.113	0.113	0.117	0.117	0.093	0.093
	8	1360	43 000	13 106	1.35	0.146	0.146	0.125	0.128	0.103	-----	0.108	0.113	0.106	0.099	0.106	0.104	0.104
2-17-65	9	1343	46 000	14 021	1.43	0.128	0.126	0.153	0.165	0.112	0.124	0.112	0.115	0.124	-----	-----	0.096	0.096
	10	1546	46 000	14 021	1.66	0.124	0.126	0.106	0.110	0.094	0.101	0.090	0.089	0.099	0.098	0.106	0.083	0.083
2-18-65	11	1303	46 200	14 082	1.65	0.116	0.114	0.106	0.108	0.099	0.106	0.098	0.102	0.104	0.095	0.098	0.090	0.087
2-19-65	12	1428	47 000	14 326	1.50	0.115	0.112	0.100	0.099	0.096	0.112	0.096	0.095	0.108	0.096	0.099	0.084	0.088
	13	1529	47 000	14 326	1.65	0.096	0.095	0.103	0.103	0.096	0.093	0.092	0.092	0.099	0.086	0.088	0.077	0.077
2-23-65	14	1345	47 000	14 326	1.65	0.111	0.107	0.109	0.105	0.099	0.103	0.097	0.100	0.111	0.101	0.105	-----	-----
	15	1545	47 000	14 326	1.65	0.110	0.109	0.107	0.103	0.104	0.114	0.096	0.098	0.108	0.094	0.094	-----	-----
2-24-65	16	1346	47 000	14 326	1.57	0.110	0.108	0.123	0.127	0.096	0.114	0.094	0.096	0.113	-----	-----	-----	-----
	17	1545	47 000	14 326	1.66	0.114	0.114	0.129	0.130	0.114	0.126	0.110	0.110	0.114	-----	-----	-----	-----
3- 2-65	18	1231	47 000	14 326	1.65	0.111	0.111	0.106	0.111	0.092	0.109	0.092	0.092	0.108	0.095	0.101	0.084	0.084
3- 9-65	19	1230	47 000	14 326	1.65	0.110	0.111	0.097	0.095	0.096	0.107	0.097	0.095	0.108	0.096	0.100	0.095	0.095
3-10-65	20	1230	47 000	14 326	1.65	-----	-----	0.108	0.105	0.095	0.089	0.094	0.094	0.100	0.084	0.086	0.079	0.079
3-11-65	21	1401	41 000	12 497	1.30	0.150	0.149	0.102	0.095	0.108	0.117	0.103	0.104	0.113	0.106	0.106	0.079	0.079
3-12-65	22	1236	38 000	11 582	1.20	0.115	0.114	0.115	0.113	0.113	0.116	0.112	0.108	0.114	0.105	0.106	-----	-----

TABLE IV.- SUMMARY OF CHICAGO SONIC-BOOM DATA FOR BOMBER AIRPLANE – Concluded

(f) Wave shape

Date	Flight	Local time, hr	Operating conditions			Wave shape for –												
			Altitude		Mach number	Station 1 at –		Station 2 at –		Station 3 at –					Station 4 at –		Station 5 at –	
			ft	m		Mike 1	Mike 2	Mike 1	Mike 2	Mike 1	Mike 2	Mike 3	Mike 4	Mike 5	Mike 1	Mike 2	Mike 1	Mike 2
2- 2-65	1	1400	43 000	13 106	1.65	N	N	---	---	---	---	---	---	---	---	---	---	---
	2	1502	47 000	14 326	1.65	N	NP	---	---	---	---	---	---	---	---	---	---	---
2- 3-65	3	1359	47 000	14 326	1.65	NP	NP	NR	NR	---	---	---	---	---	---	---	---	---
2- 4-65	4	1357	47 000	14 326	1.53	NR	NR	---	---	---	---	---	---	---	NP	NP	---	---
2- 5-65	5	1359	46 800	14 265	1.63	P	R	NP	NP	P	P	---	---	---	NP	NP	---	---
2-10-65	6	1330	46 300	14 112	1.65	R	R	R	R	NR	NR	---	NR	NR	N	N	---	---
2-12-65	7	1231	48 000	14 630	1.43	R	R	P	P	R	R	R	R	R	R	R	P	P
	8	1360	43 000	13 106	1.35	C	C	P	P	P	P	NP	NP	NP	P	P	P	P
2-17-65	9	1343	46 000	14 021	1.43	R	R	R	R	NP	NP	P	R	R	---	---	NR	NR
	10	1546	46 000	14 021	1.66	NR	NR	N	NR	NR	NP	P	P	N	NR	NR	NP	NP
2-18-65	11	1303	46 200	14 082	1.65	R	R	NR	NR	P	N	NP	N	NR	N	N	NR	NR
2-19-65	12	1428	47 000	14 326	1.50	NR	NR	N	N	NP	N	N	N	N	N	N	NP	NP
	13	1529	47 000	14 326	1.65	NR	NP	NR	NR	N	N	N	N	N	N	N	NP	NP
2-23-65	14	1345	47 000	14 326	1.65	N	N	NP	N	N	N	N	N	N	N	N	N	N
	15	1545	47 000	14 326	1.65	N	N	N	N	NR	NP	NR	NR	N	N	N	N	N
2-24-65	16	1346	47 000	14 326	1.57	P	P	R	R	N	N	N	N	NR	N	N	NP	NP
	17	1545	47 000	14 326	1.66	R	R	R	R	R	R	R	R	R	P	P	NP	NP
3- 2-65	18	1231	47 000	14 326	1.65	NR	NR	NR	NR	N	N	N	N	N	NR	NR	NP	NP
3- 9-65	19	1230	47 000	14 326	1.65	NP	P	N	N	N	N	NR	N	NR	N	N	NR	NR
3-10-65	20	1230	47 000	14 326	1.65	---	---	NR	NR	N	N	N	NR	NP	N	N	NP	NP
3-11-65	21	1401	41 000	12 497	1.30	R	R	NR	NR	R	NR	R	NP	R	NR	NR	P	P
3-12-65	22	1236	38 000	11 582	1.20	NP	NP	NR	NR	N	N	N	N	N	NR	NR	---	---

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